

Agroforestry for Livelihood Security in Agrarian Landscapes of the Padma Floodplain in Bangladesh

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Accepted: 19 January 2012 / Published online: 5 February 2012
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Abstract In the Padma floodplain of Bangladesh, the traditional system of agriculture has become unsustainable due to high population growth. Mango-based agroforestry which has been practiced by the farmers since the 1990s, is a promising alternative and is considered as one of the few options to lift farmers out of poverty and improve livelihood security. This paper examines the potential of mango-based agroforestry to improve livelihoods, using data collected by rapid rural appraisal, farmer participatory research, stakeholder analysis and a farm household survey in six representative villages in the floodplain. Farmers with the least land were found to allocate a higher percentage of their land to agroforestry, and the increased income from agroforestry compared to other agricultural systems helps reduce relative poverty. This income maintains basic household needs, providing food security and fuelwood, and contributes to healthcare, housing and sanitation conditions, and meeting educational expenses.

Keywords Population growth · Sustainable land use · Income generation · Women empowerment

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Introduction

Due to steadily increasing population pressures in the Padma floodplain of Bangladesh coupled with expansion of urban and industrial areas, farmers have been forced to shorten the fallow period, thereby accelerating soil erosion and nutrient depletion. This situation threatens the livelihoods of people dependent on agriculture. Agroforestry provides potential for more sustainable land use. Deliberate maintenance or cultivation of trees or other woody plants with crops or pasture has multiple benefits, and can provide farmers, communities and society at large with a wide array of forest-related goods and services (MacDicken and Vergara 1990).

Combining trees, crops and vegetables is an age old composite farming system in Bangladesh (Alam et al. 1996). It was embedded in the traditional forest plantation activities by way of taungya.¹ Taungya was first introduced in Burma, and was adopted in Bangladesh at Kaptai in the early 1870s, where 8 ac of shifting cultivation land was planted by the local farmers in a form of social forestry² (Alim 1993). Multi-strata agroforestry systems have been an active agricultural tool for Bangladeshi farmers since 1980, under various development projects of both government and non-government organizations, including the Asian Development Bank and European Union (Rahman et al. 2008). The *homestead* areas of rural Bangladesh form a unique system combining trees, shrubs, vegetables and poultry (Abedin et al. 1990; Siddiqui and Khan 1999). The integration of trees into farming systems is evident throughout Bangladesh. Growing betel vines on trees and the cultivation of pineapple in jackfruit orchards are common practices in tribal areas including Madhupur and Maulvibazar (Rasul et al. 2004).

Mango-based multistorey cropping is widely practiced in the Padma floodplain. It is an agrosilvicultural cropping system in which the multipurpose tree species mango is grown with alley crops of paddy rice, wheat, sugarcane, papaya, banana, ginger, turmeric and various species of vegetables, including potato, an edible bean (*Dolichos lablab*), and lady's finger (*Abelmoschus esculentus*). This cropping system is promoted by the government and NGOs³ for the multiple purposes of livelihood security and product diversification, increased production and income generation, and soil and water conservation. Paddy rice, wheat, sugarcane, papaya and banana are intercropped in the early phase of the system (for up to 8 years). After the harvest of the early-phase crops and the closure of the mango canopies, the shade-tolerant ginger and turmeric are commonly planted, together with vegetable crops, leading to the development of a multi-storey system.

This paper investigates the impacts of mango-based multi-storey cropping systems on farm households with respect to income generation and provision of cash for educational expenses, food security, improved health care, housing and

¹ The taungya system involves the planting of cash or food crops between newly planted forest seedlings in a reforestation or plantation project (Alam et al. 1996).

² 1 ac = 0.41 ha.

³ The Government and NGOs provide farmers with essential information, training and subsidised seeds and seedlings.

sanitation conditions, as an agroforestry system in northern Bangladesh primarily introduced by the District Forestry Office of the Government of Bangladesh.

Research Method

Six villages were selected in Paba and Charghat upazila⁴ in the Padma floodplain in Rajshahi district of Bangladesh were selected (Fig. 1), the main criterion being presence of farmers experienced in the mango-based multi-storey cropping systems. All villages lie between 24°25' to 24°20' north latitudes and between 88°40' to 88°45' east longitude in the tropical monsoon climate zone. Most inhabitants of the study area are subsistence farmers, and suffer from poor infrastructure and social conditions. Data were collected during September 2009 to March 2010, through rapid rural appraisal (RRA),⁵ direct observation, and a survey of mango-based agroforestry farmers. A sample of 110 farmers was purposively selected from the six villages, representing 30% of the farmer population who are currently practicing mango-based agroforestry. Due to unequal number and scattered location of the farmers in the villages, unequal proportions of households were drawn from the villages. A questionnaire was developed to investigate socio-economic impacts of agroforestry at the household level, and was tested on six households in the survey area. Four research assistants were employed to conduct the survey, under supervision of researchers, and the response rate was 100%.

Other data were collected by interviews of key informants, including government forestry officers and members of non-government organizations working in the study area. Secondary data were obtained from the Government household census and local administrations. Quantitative and qualitative data analysis methods were applied.

Results

All survey respondents were found to have secure tenure to the land they cropped. Land size per household averaged 1.35 ac, with 39% used for mango-based agroforestry, 46% for commercial agriculture (particularly monocropping of rice, wheat and sugar cane), and a further 9% for home gardens.

The majority of the farmers could be classified as poor,⁶ yet they allocated a substantial proportion of their land to agroforestry, nearly 65% allocating at least 0.5 ac. Agroforestry area varied greatly between farms of the same size, averaging about 0.5 ac, farmers with the least land allocating a relatively high percentage to agroforestry to utilize their land intensively to maintain their livelihoods. The

⁴ An upazila is a sub-district.

⁵ RRA was conducted with the people of study site to understand basic information of the villages (e.g. location of farm households, distance of cultivation fields, crop calendar).

⁶ In this study 'poor' has been defined by considering farmers' incomes. 'Poor' are taken as those with incomes of not more than US\$1.25 per person per day, following UNDP (2010).

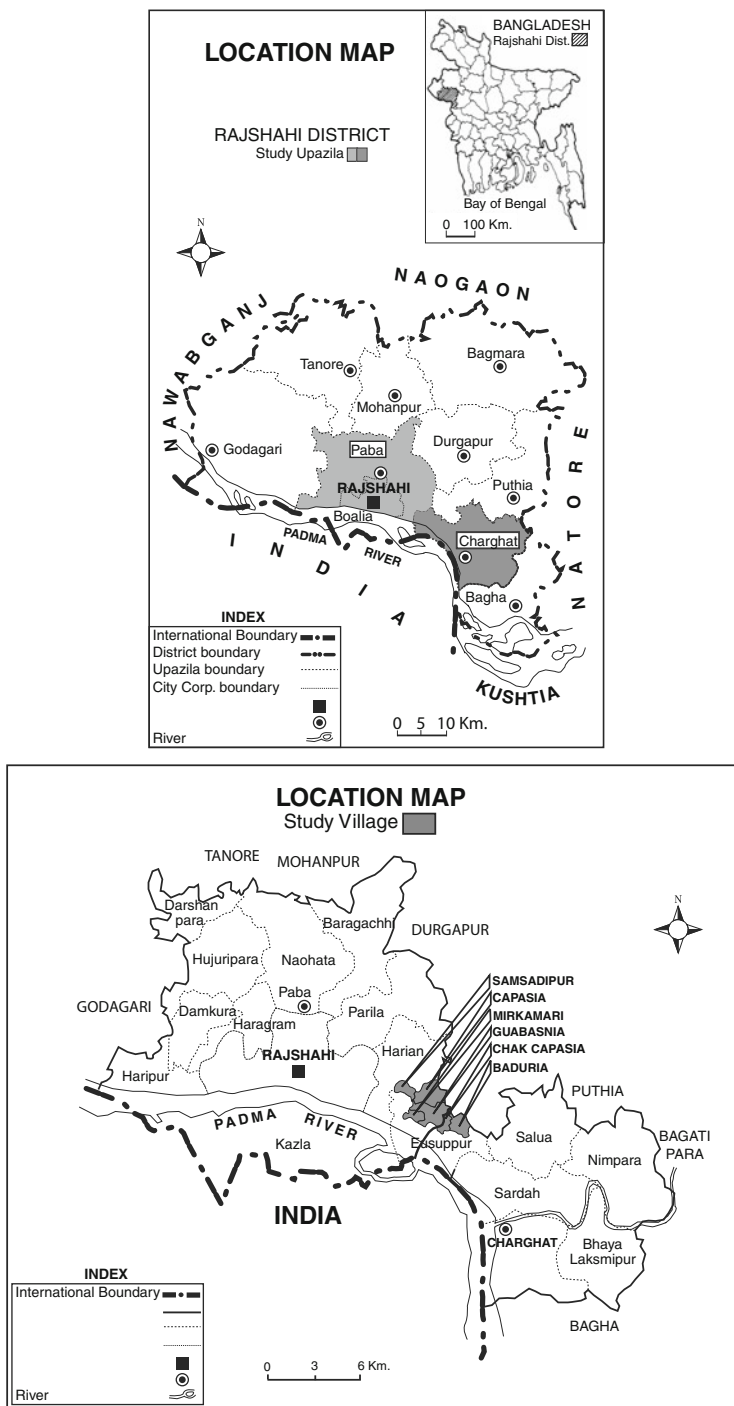


Fig. 1 Location of study villages

Table 1 Yearly household income earned from various sources in the study site (n = 110)

Statistic	Agroforestry	Agriculture (monoculture)	Business	Service	Other
Mean income (US\$)	226.87	126.34	185.43	173.13	34.97
SD (US\$)	136.02	73.60	180.80	210.52	84.19
Median (US\$)	205.88	117.65	176.47	0.00	7.35
Minimum (US\$)	108.82	205.88	0.00	0.00	0.00
Maximum (US\$)	544.12	382.35	529.41	529.41	367.65
Mean share of total income (%)	30.00	17.00	25.00	23.00	5.00

These figures are for sample farmers who are practicing agroforestry

monocropping of rice, wheat and sugarcane sufficiently maintains the livelihoods of those with larger landholdings, averting the higher establishment costs and requisite technical skills and knowledge needed for agroforestry.

Contribution of Agroforestry to Poverty Reduction

Through agroforestry, the amount and diversity of forest products increased substantially in all six survey villages, and these products were used by local households to support subsistence needs as well as for income generation through the cash sale of surplus produce. The value of produce harvested from agroforestry plots averaged US\$ 226.87 per year (Tables 1, 2),⁷ providing about 30% of total household income.

Crop species (paddy rice, wheat, sugarcane, banana and papaya) in agroforestry play a critical role in supplying household food demand as well as income generation. As a fruit, mango is a major source of income. Mango timber is used for furniture and building construction, and leaves and bark are used medicinally. The leaves are also used as animal fodder and as fuel for cooking. The mango is also an important Hindu religious plant, and the fruit and leaves are used in religious ceremonies.

The most important contribution of agroforestry has been to increase the economic security, household resilience and livelihood opportunities of rural households. The devolution of forest management through agroforestry to local communities has empowered villagers with a greater say over the resources upon which their livelihoods depend, and women, the poor and other marginalized groups have been able to participate in decision-making processes traditionally closed to them. Agroforestry has increased people's sense of security by performing an important 'safety-net' function, which helps them through periods of increased vulnerability, such as crop failures, natural disasters and illness. Agroforestry has also helped households to secure tenure over farm areas and prevent illegal logging, forest encroachment and 'land-grabbing', a significant problem in Bangladesh.⁸

⁷ USD 1 = BDT (Bangladesh Taka) 68.40 as of November 2009.

⁸ Land-grabbing is prevented because planting trees improve resource tenure by greater monitoring and control over land.

Table 2 Agroforestry products harvested in the case study villages

Local or English name	Scientific name	Local or English name	Scientific name
Vegetables		Fruit	
Lalshak	<i>Amaranthus gangeticus</i>	Mango	<i>Mangifera indica</i>
Tomato	<i>Lycopersicon esculentum</i>	Papaya	<i>Carica papaya</i>
Datashak	<i>Amaranthus lividus</i>	Banana	<i>Musa species</i>
Bean	<i>Dolichos lablab</i>	Field crops	
Lady's finger (Okra)	<i>Abelmoschus esculentus</i>	Paddy	<i>Oryza sativa</i>
Potato	<i>Solanum tuberosum</i>	Wheat	<i>Triticum aestivum</i>
Pumpkin	<i>Cucurbita pepo</i>	Sugarcane	<i>Saccharum officinarum</i>
Brinjal	<i>Solanum melongena</i>		
Chilli	<i>Capsicum annum</i>		
Turmeric	<i>Curcuma domestica</i>		
Spinach	<i>Spinacea oleracea</i>		
Ginger	<i>Zingiber officinale</i>		

All species listed above are used for domestic consumption and sold in local markets

Agriculture, wage labour and small business are the greatest sources of cash income in the study area. The processing and marketing of agroforestry products—e.g. charcoal, fence posts, poles, and dried food from fruits, vegetables, and cereal crops—plays a critical role for income generation. In this way, agroforestry specifically has a supporting role in raising income levels of poor households and thus reducing poverty within the wider community.

Contribution to Food Security

Agroforestry products constitute a high proportion of household food production. Survey respondents were found to obtain 60% of their staple crops (paddy, wheat), 80% of vegetables (potato, tomato, bean, lady's finger, turmeric, spinach, brinjal, ginger) and 75% of fruit (mango, papaya and banana) from agroforestry. In addition, the diverse products (especially fruit and vegetables) are available year-round within agroforestry systems. Diverse crop production also reduces risk of pest and disease infestation, and climate-related and other shocks. Agroforestry products also provide a major feed supply for poultry.

Contribution to Health and Nutrition

Agroforestry contributes to meeting major costs of household healthcare through the sale of surplus products. The yearly average household healthcare expenditure is US\$ 198.77, of which agroforestry was found to contribute 71%. The diverse products harvested in agroforestry systems—particularly fresh vegetables and fruit—are a major source of dietary minerals. This is especially important for women and children because there is a poor access to healthcare facilities in Bangladeshi society.

More than 80% of household members were found to depend on medicinal plants for their primary medical needs. Plant remedies are prepared from parts of plants roots, bark, leaves, flowers and fruits. These are taken in either fresh or dried form and are applied both internally and externally. Some medicinal plant parts are also cooked and served with meals or for external use as pastes. For example, kalakacheu (*Plumiera alba*) is consumed for body pain, arthritis and gastric pain, and it is also applied to treat cataracts. Turmeric paste is applied externally for skin infections. Ginger is consumed by the people to reduce pain from pharyngitis. The juice from leaves of tulshi (*Ocimum sanctum*) mixed with honey is used as a medicine for long-term (chronic) coughs.

Contribution of Agroforestry to Education

The income from agroforestry assists in meeting education expenses of both boys and girls. The average yearly household educational expenditure is US\$ 33.76, for which the average of percentage contribution of agroforestry is 72%. The major expenditure comes from the sale of fruit and timber from agroforestry.

Agroforestry has a lower labour requirement than intensive agriculture. In Bangladeshi society young boys participate in agricultural activities along with older family members, but with agroforestry systems, young boys in particular can conserve their time and focus more on their education. Women and girls are responsible for collecting fuelwood, fodder and water for their families, and because agroforestry systems constitute a significant source of fuelwood and fodder young girls have more time for education.

Contribution to Housing Condition, Sanitation and Energy Consumption

Due to increased income earned from agroforestry, improvements can be made to housing, sanitation and fuelwood consumption. Agroforestry appears to make a strong contributor to improving housing. Before commencing agroforestry projects the housing condition of the households was 56.4% *katicha* (made from straw, sand and wood) and 43.6% *semi pacca* (wood, tin and brick). These percentages changed to 19.1 and 48.1% after introduction of agroforestry, with 39.1% of houses being made of *pacca* (brick), due to increased disposable income from agroforestry. Sanitation conditions also improved after the introduction of agroforestry, the percentage of households with sanitary latrines increasing from 43.6 to 70.9%.

Wood, tree branches, leaves and straw are the main household cooking fuels. Agroforestry provides 40% of fuel requirements, another 40% coming from home gardens and 20% from agricultural fields.

Women's Participation in Agroforestry

Some females were found to be involved in agroforestry as sole farmer (19.1%), thus agroforestry had improved their social and economic status. It was found that 33% of female agroforestry farmer had been widowed, so they become involved in agroforestry to feed themselves and their families. About 67% of married females

had elderly and frail husbands (none had never married), so they took over the farming tasks.

Both male and female family members play a critical role in agroforestry by working together in tree improvement and propagation. Women share the responsibility with men for tree and crop protection, irrigation, weeding and harvesting of annual crops. Women are also responsible for the post-harvest storage and processing of food products, e.g. for homemade food from fruits, vegetables and cereal crops for both household consumption and for the market.

Historically, male-dominated Bangladesh society believed that women should stay at home and manage the household, and their basic rights (including physical and mental healthcare, education and expression of opinion) were often violated. However, the valuable role they play in agroforestry has considerably enriched their social and economic status, empowerment and decision-making. This directly and indirectly affects their fertility, health and nutritional status. Box 1 is an example of how could two women empowered themselves to the decision-making process by practicing agroforestry.

Discussion

From above results, it is clear that mango-based agroforestry plays a major role in supporting the socio-economic needs and improving the livelihood conditions of the people in Rajshahi district of the Padma floodplain of northern Bangladesh. Some farmers in the study area are practicing agroforestry, which is well organized, ecologically sound, and could provide high yields from fruit trees which contribute to sustainable livelihoods. Agroforestry is a viable livelihood option to raise income and reduce poverty as well as improving sustainable livelihoods. Although monoculture and homestead agroforestry are established practices, the alternative agroforestry system of mango-based alley cropping is playing a vital role in rural livelihood strategies. Data collected in this study clearly indicates that poor farmers

Box 1 Example of gender and empowerment through agroforestry

Jamila and Najera (of Chack Capasia) are neighbours and engaged in mango based agroforestry, which was established in 1994. Jamila and Najera are in their 40 s, and mothers of four and six children, respectively. Jamila is widowed and Najera's husband is disabled and both previously worked as agricultural labourers. Before practicing agroforestry, as they remember, 'The area was highly degraded, and people used to leave their cattle to graze on their land'. Involvement in agroforestry and its income have given them some voice in what happens around them. Najera, for example, has managed to send their children to the local primary school, despite the opposition of her husband: 'My husband wanted the boys to go to work as labourers to help the family... I said, 'If they start going to work, they would also end up becoming wage labourers like their father... I want to send them to school. At first, the village headman also supported [my husband]. I told the man about my decision. Eventually the headman agreed and said to my husband, 'Let the boys go'. These ladies are also quite conscious about their increased status and recognition: 'Many 'big' [high ranking] men from the town come and talk to us; they come from Rajshahi with vehicles... Many women from [the nearby] villages come [to us] to learn about agroforestry [development]...'.

are the main users and beneficiaries of agroforestry. Agroforestry also plays a role in restoring and maintaining the ecological functions of the landscape (Rahman et al. 2007). Alam et al. (1996) observed that a large number of marginal farmers earn their livelihood for a particular period of the year from agroforestry. Poor farmers adopt agroforestry to utilize their land more efficiently because they have limited access to other resources (Siddiqui and Khan 1999). It is financially more profitable to local farmers than traditional cultivation. Thus, it can be a potential alternative cultivation practice that helps to reduce poverty and transition to permanent cultivation (Mai 1999).

Monoculture is still the primary type of land use in the study area, with an inherent local belief that monoculture is incompatible with production of staple food, including rice and wheat. However, this belief is no longer suitable for meeting increasing food demand due to high population growth. Monoculture agriculture cannot venture into taking risk by investing in more intensive land uses particularly for long-term crops including trees and shrubs. It also influences farmers' access to formal credit, which usually requires collateral. Further, Bangladeshi monoculture farmers lack access to modern cultivation knowledge, because extension agents and credit agencies are only located in sub-district headquarters, far away from most farmers. These agencies are usually not aware of the socio-economic values (e.g. patronage and social stratification) of the local population and the agroforestry technologies suitable for remote areas (Rasul et al. 2004).

The research findings lead to the conclusion that agroforestry could be considered as one of the major strategies for sustainable household development in the Padma floodplain. Agroforestry not only helps to increase the output of food and household income but also increases the tree cover in agricultural landscapes on private land where unemployed and poor people can earn their livelihood.

Conclusion

Agroforestry is a time-tested example of sustainable land-use practice in the Padma floodplain of Bangladesh. However, institutional support needs to comprise, most importantly, agricultural extension services and credit facilities. There is a need for the government to design and implement an extension program to meet the extension needs of local farmers. Substantial initial investment is needed to move from monocropping to agroforestry. Most farmers lack investment funds, and the Bangladesh Agricultural Bank, which is mandated to provide agricultural credit, does not provide credit for tree growing (Rasul et al. 2004). Hence poor farmers are forced to obtain loans from local moneylenders at high interest rates, which further reduces their ability to make investments in land. Provision of both short- and long-term formal credit would enable farmers to overcome the shortage of investment funds.

Acknowledgments We wish to thank the Department of Sociology of the University of Rajshahi, CIFOR and the IC-SAAKTI Project for providing financial support for this research. We are also grateful to Professors Khan, Siddiquee and Hossain for their valuable advice and guidance. Many thanks are also given to the farmers at the field survey sites, who shared their precious time, thoughts and concerns, and even their sometimes scarce meals with us.

References

- Abedin MZ, Lai CK, Ali MO (eds) (1990) Homestead plantation and agroforestry in Bangladesh. Bangladesh Agricultural Research Council and Winrock International, Dhaka
- Alam MK, Mohiuddin M, Basak SR (1996) Village trees of Bangladesh: diversity and economic aspects. *Bangladesh J For Sci* 25(2):21–36
- Alim A (1993) Agroforestry practices in Bangladesh. In: Mahat TBS (ed) Agroforestry training course module in Bangladesh. Bangladesh Agricultural Research Council, Dhaka, pp 21–29
- MacDicken KG, Vergara NT (1990) Agroforestry: classification and management. Wiley, New York
- Mai PT (1999) Socio-economic analysis of shifting cultivation versus agroforestry system in the upper stream of lower mekong watershed in Dak Lak province. M.A thesis in Economics of Development. College of Economics, National University-HCMC, Viet Nam and Institute of Social Study (ISS), Rotterdam
- Rahman SA, Rahman MF, Codilan AL, Farhana KM (2007) Analysis of the economic benefits from systematic improvements to shifting cultivation and its evolution towards stable continuous agroforestry in the upland of eastern Bangladesh. *Int For Rev* 9(1):536–547
- Rahman SA, Groot WD, Snelder DJ (2008) Exploring the agroforestry adoption gap: financial and socioeconomics of litchi-based agroforestry by smallholders in Rajshahi (Bangladesh). In: Snelder DJ, Lasco RD (eds) Smallholder tree growing for rural development and environmental services: lessons from Asia. Springer, The Netherlands, pp 227–244
- Rasul G, Thapa GB, Zebisch MA (2004) Determinants of land-use changes in the Chittagong hill tracts of Bangladesh. *Appl Geogr* 24(1):217–240
- Siddiqui MA, Khan NA (1999) Floristic composition and socio-economic aspects of rural homestead forestry in Chittagong: a case study. *Bangladesh J For Sci* 28(1):94–101
- UNDP (United Nations Development Programme) (2010) Human development report 2010. Palgrave Macmillan, New York